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AN ANALYSIS OF THE ELECTRICAL PROPERTIES  
OF THE  
GP-1 PRODUCTION PROTOTYPE  
(HOTSHOT)

# COMMUNICATIONS DEVELOPMENT LABORATORY

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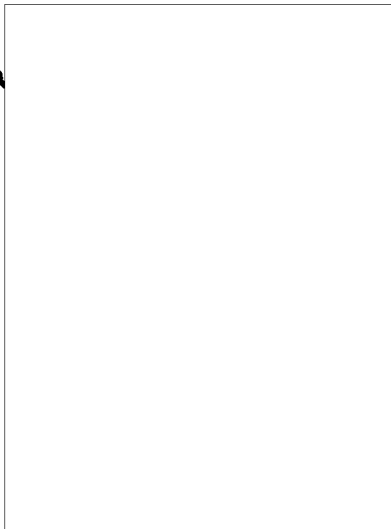
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GP-1 PRODUCTION PROTOTYPE  
(HOTSHOT)

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1. INTRODUCTION

The production prototype of the GP-1 (HOTSHOT) miniature gasoline-driven alternator, under Contract RD-13, was delivered to the Analysis and Appraisal Unit, Research and Development Branch, for testing. Since there was only one unit available, it was deemed inadvisable to dismantle the unit for a complete mechanical investigation at this time. This report, therefore, is concerned mainly with the electrical and operational properties of the alternator.

2. SUMMARY

The GP-1 is a compact, portable, gasoline-driven alternator which measures  $7\frac{1}{2}$  by  $8\frac{1}{4}$  by  $6\frac{1}{2}$  inches and which weighs 12 pounds when filled with gasoline. The gas tank capacity is 20 fluid ounces, sufficient for  $3\frac{1}{3}$  hours operation with a 100 watt load. Although rated at 100 watts, 115 volts, and 400 cps at 6000 rpm, the unit is capable of delivering 150 watts at temperatures of 90 degrees F. and at the atmospheric pressures encountered at sea level. This amount of power is more than adequate for the operation of most agent communication equipment. Operationally, the starting characteristics and speed regulation with constant load are excellent.

3. DESCRIPTION AND EVALUATION

3.1. Mechanical

(Note: As explained in the introduction, much of the information in this section will be compiled at a later date when an engine break-down is authorized.)

3.1.1. Specifications

3.1.1.1. Engine

3.1.1.2. Ignition

3.1.1.3. Carburetion

3.1.1.4. Muffling

3.1.1.5. Cooling

3.1.1.6. Lubrication

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3.1.1.7. Accessories and Spares

The following spares were received with the unit as shipped:

- (1) One set of breaker points
- (2) One spark plug
- (3) One spare length of pull rope
- (4) One pull rope and handle

3.1.1.8. Size and Weight

Size -  $7\frac{1}{2}$  inches high by  $8\frac{1}{2}$  inches wide by  $6\frac{1}{2}$  inches deep  
Weight - 12 pounds with fuel

3.1.2. Construction

3.1.3. Operation

The GP-1 has four operational controls; a fuel shut-off valve, a throttle, a choke, and a mixture control.

To start the engine when cold, the gas tank cap is securely tightened, the choke is placed in the ON position, the throttle is opened to one-third, the fuel shut-off is opened, and the engine is pulled through sharply. It is important that the pull rope be wound on the starting pulley in the direction indicated by the arrow; otherwise, the engine will start and run in reverse but cannot be loaded. Instead of a gravity fuel-feed system requiring a vented fuel tank, this engine operates on a pressure feed, requiring that the gas tank cap be seated tightly.

The first pull on the starting rope creates sufficient pressure in the tank for starting. For the second or starting pull, the choke is opened half way and the throttle advanced half way.

Once the engine has started, the choke is turned OFF and the throttle is set for a speed of 6000 rpm. With a 100 watt load, this speed corresponds to the red mark on the voltmeter mounted on the front panel. When the engine has been stopped but is still hot, it will normally start with one pull, if the choke is closed part way.

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- 3.1.3. The mixture control, a screwdriver adjustment atop the carburetor, needs readjustment only when the load is changed. There is a proper setting for each load, which is determined while adjusting the throttle. The following are optimum conditions: smooth running with an absence of popping and vibration, a speed of 6000 rpm, and a gray colored exhaust.

The engine is stopped by turning the fuel shut-off valve to OFF and closing the throttle when the speed has decreased slightly.

Flooding will be experienced if the choke is not turned OFF as soon as possible after the engine starts, or if the choke is turned ON while the engine is running. To remedy this situation, the spark plug must be removed from the cylinder head and the engine "pulled through" a half dozen times. The spark plug should be wiped dry and placed in the cap so that it will fire when the engine is pulled through and prevent break-down within the ignition transformer. The spark plug and ignition cable are replaced and the starting procedure is resumed.

It should be noted that the voltage indicator on the front panel can be used in lieu of a tachometer only when the load is 100 watts. For other loads a tachometer is required to set the speed to 6000 rpm, assuring a frequency of 400 cps and proper mechanical timing.

3.1.4. Maintenance

3.1.5. Tests

3.1.5.1. Rate of Fuel Consumption

When loaded to 100 watts, 80 per cent lagging power factor, at a speed of 6000 rpm, the GP-1 will run for 1 3/4 minutes on 5 milliliters of fuel.

3.1.5.2. Gas Tank Capacity

The gas tank capacity is 20 fluid ounces, or approximately 590 milliliters.

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### 3.1.5.3. Running Time

The total running time per tank-full of fuel when loaded to 100 watts, 80 per cent lagging power factor at a speed of 6000 rpm, is approximately 3 1/3 hours.

### 3.1.5.4. Operating Temperatures

The following temperatures were recorded after the unit had been delivering 40 watts for a period of thirty minutes.

Throttle control	130 Degrees F.
Choke control	130
Gas tank cap	118
Spark plug cap	190
Carburetor cap	130
Breaker point cap	160
Muffler	235
Exhaust gas	190
Exhaust air	215
Intake air (ambient)	90

## 3.2. Electrical

### 3.2.1. Specifications

Voltage	115 vac at 100 watts, 80% lagging power factor
Power	100 watts
Frequency	400 cps at 6000 rpm
Phase	single phase
Field excitation	permanent magnet
Stabilization	keeper stabilized rotor
Number of poles.	8 poles
Rotor speed	6000 rpm

### 3.2.2. Construction

Since the internal inspection of the alternator involves an extensive tear-down of the GP-1, it was decided to inspect the alternator at a future date when the unit will be completely dismantled for the mechanical examination.

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- 3.2.2. However, a superficial examination of the electrical system indicates that satisfactory protection has been afforded all wiring and component parts. The use of conduit and junction boxes for all cabling and electrical connections, together with a potted ignition transformer and saturable reactor, protects the electrical system from damage due to water, gasoline, and oil.

Note : This alternator is of the keeper stabilized type and should never be dismantled by inexperienced personnel.

3.2.3. Ignition System

The GP-1 ignition system is a parasitic type, consuming about 6 watts. A line transformer with a great amount of leakage inductance is connected across the alternator output. The inherent regulatory action of this type transformer is the key to the excellent starting characteristics of this unit. As much spark is developed at cranking speeds when the alternator is delivering 20 volts as is developed at the running speed of 6000 rpm when the output voltage is 115 volts.

The voltage from the secondary of this line transformer is rectified and applied to the storage capacitor. For each revolution of the engine, the breaker points close and discharge the capacitor into the spark transformer. Shortly after the points close, the current change in the primary is sufficiently great to cause a voltage to be generated in the secondary of great enough magnitude to arc over at the spark plug. The use of a capacitor across the points is unnecessary, the inductance of the primary being sufficiently large to prevent current flow at the instant of contact.

3.2.4. Tests

3.2.4.1. Terminal Voltage as a Function of Load and Power Factor at 6000 rpm

See curve.

3.2.4.2. Terminal Voltage as a Function of Speed and Load at Unity Power Factor

See curve.

3.2.4.3. Speed Regulation

When loaded to a constant 100 watts with the correct mixture setting, the GP-1 consistently maintains speed to within plus or minus 2 parts in 60, or plus or minus 3 per cent.

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3.2.4.4. Radio Interference

Radiated noise measurements taken in accordance with JAN-I-225, between the limits of 0.3 and 20 megacycles, indicate that the unit does not meet specifications. The noise is particularly objectionable between 5.0 and 14.0 megacycles.

3.2.4.5. Field Test with RS-6

A field test was conducted to investigate RS-6 operation when powered by the GP-1. It was found that except for radio interference the operation of the GP-1 was satisfactory. Through the use of a 100 foot power cable, exhaust noise was reduced to a level comparable and similar to a locust's hum and did not interfere with operation or low level conversation. By moving the power supply progressively closer to the operator, it was found that the noise level at 50 feet is the maximum tolerable with the present muffler.

Voltage regulation after warm-up was excellent with a variation of only plus or minus 2 volts in 115. Because of the ideal load shift characteristic of the RS-6, no change in load occurs when the transmit key is depressed. Objectionable radio interference was experienced in the 5.0 to 14.0 megacycle frequency band.

It was deduced that the major source of interference was radiated rather than conducted noise because removal of the antenna from the RS-6 eliminated the interference.

3.2.4.6. Bench Test with RS-1

The GP-1 proved to be a suitable power supply for the RS-1. The line voltage varied from 122 volts key-up to 102 volts key down; however, this change did not cause the signal to chirp. Radio interference was experienced between 5.0 and 14.0 megacycles.

4. CONCLUSIONS

4.1. Mechanical

4.2. Electrical

The results of these tests indicate that except for (1) Radio interference, (2) Exhaust noise, (3) Hot controls, the GP-1 is acceptable for agent radio station operation with power requirements up to 100 watts. Its compact size and light weight are very desirable features for this type application.



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- 4.2. Easy, reliable starting, good speed and voltage regulation, and 3 1/3 hours' running time per tank-full of fuel are additional desirable characteristics of this unit.

The GP-1, having no flywheel or governor, was designed to power constant loads at a speed of 6000 rpm. When delivering 100 watts with the correct mixture setting, it consistently maintains speed and voltage to within plus or minus 2 parts in 60, or about plus or minus 3 per cent. Light intermittent changes in load, such as are experienced when keying a transmitter, cause decreases in speed and voltage; but in the case of the R3-1, these changes were tolerable and had no detrimental effects on operation.

5. RECOMMENDATIONS

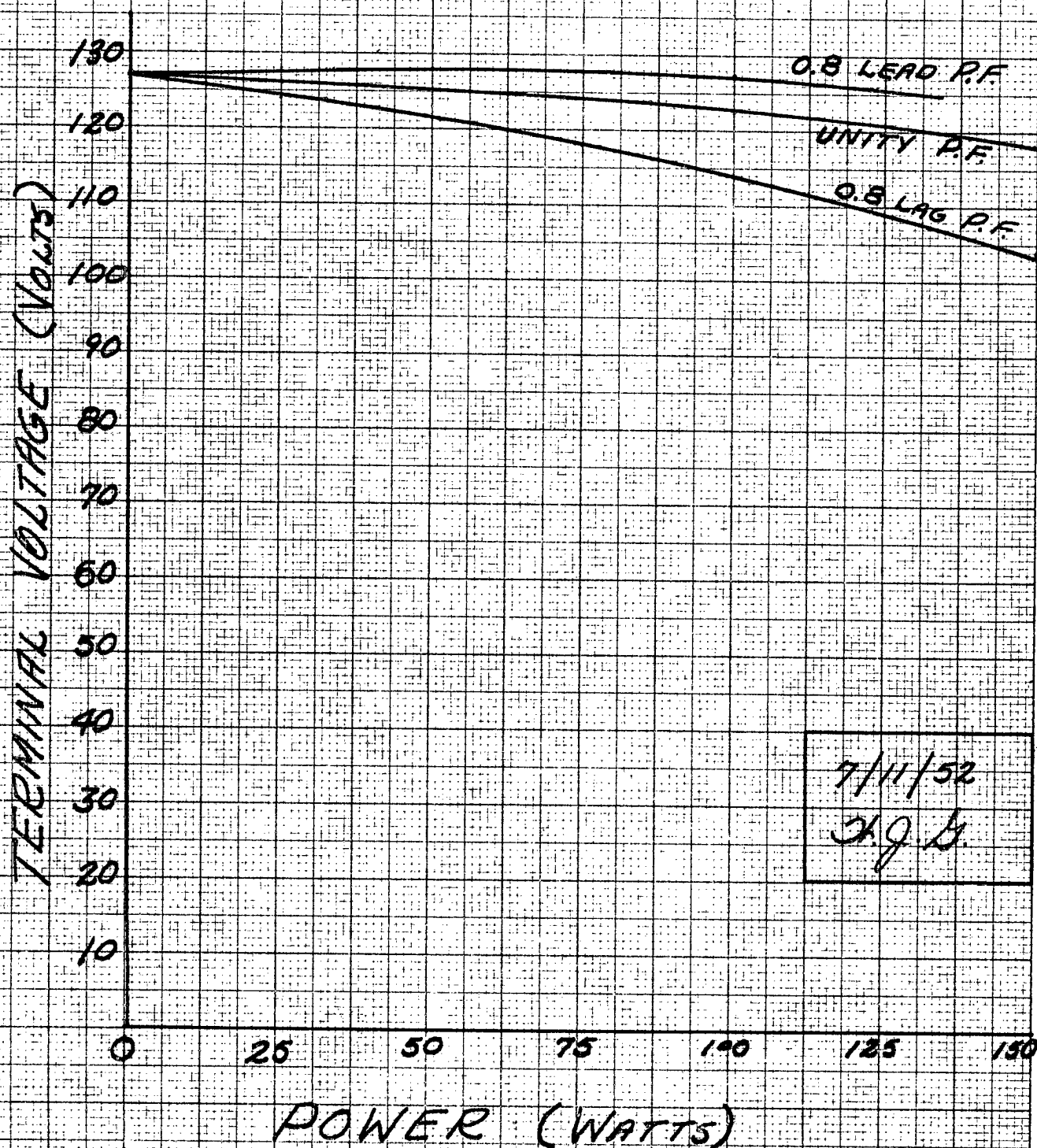
5.1. Mechanical

5.2. Electrical

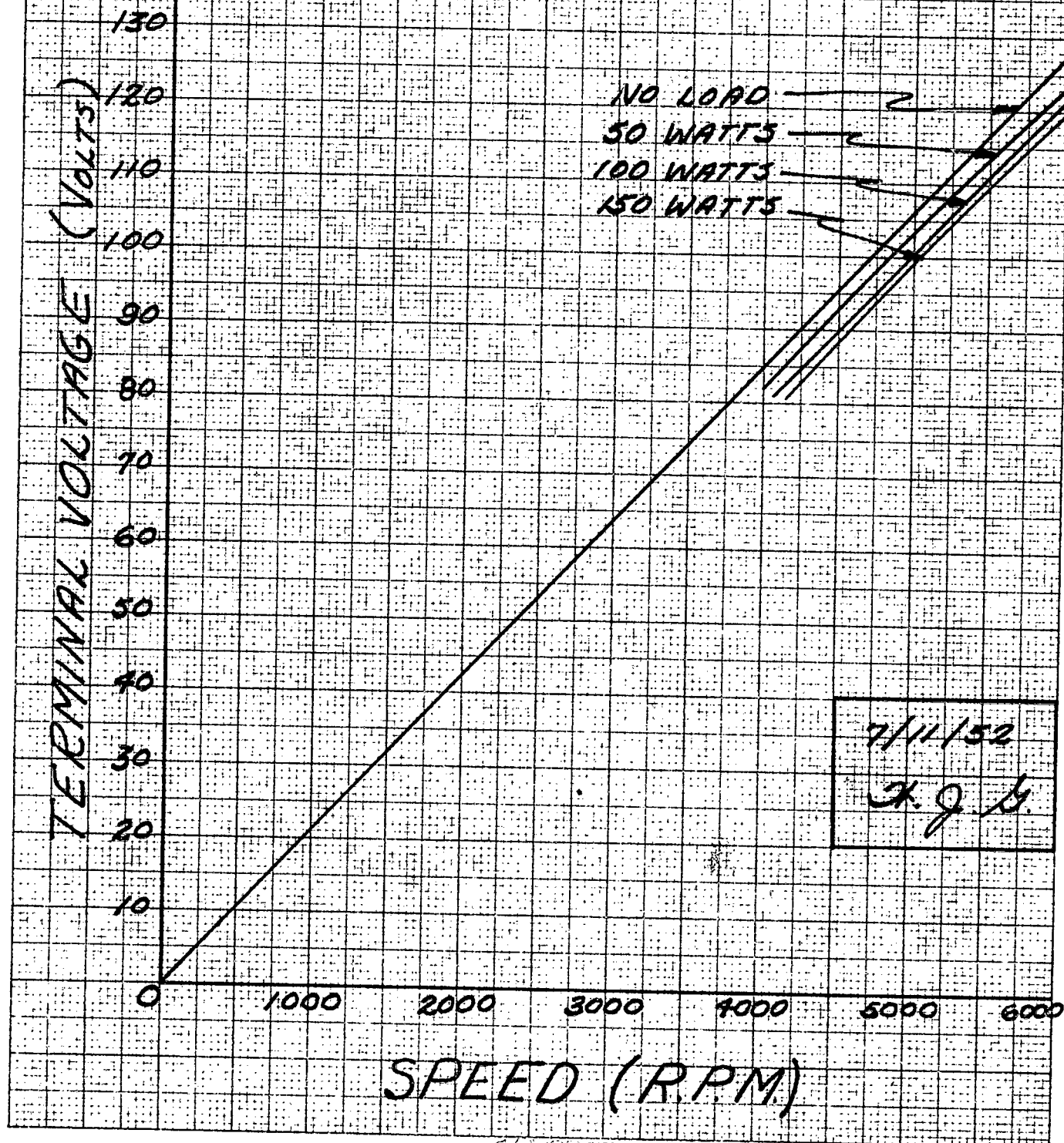
The following recommendations are offered as suggestions to improve the GP-1:

- (1) Radio interference should be decreased in order to meet specifications.
- (2) A suitable muffler should be designed to decrease the exhaust noise, permitting operation of radio equipment at a distance of 20 feet or less.
- (3) The addition of a radial arm to the throttle control would permit finer adjustment and lower the control's temperature, which at present heats to 130 degrees F.
- (4) A better gasket is needed for the fuel tank cap to prevent leakage under pressure.
- (5) For loads other than 100 watts, the voltmeter needs additional calibration marks. An alternate solution would be the inclusion of a tachometer with the accessories.
- (6) There should be a printed notice on the alternator stating that the rotor is keeper stabilized and should not be removed except by qualified personnel.

## RD-13 PRODUCTION PROTOTYPE

TERMINAL VOLTAGE AS A FUNCTION  
OF LOAD & POWER FACTOR AT A  
SPEED OF 6000 R.P.M.

## RD-13 PRODUCTION PROTOTYPE

TERMINAL VOLTAGE AS A FUNCTION  
OF SPEED & LOAD AT UNITY POWER  
FACTOR.

# Additional Comments and recommendations as a result of break down AUG. 25, 1952

## 1. Mechanical

1.1 Master rod rubbing against crankcase  
in two places.

1.2 Crankshaft counter weights rub against  
master rod

1.3 Construction is good and the unit  
is well built.

## 2. Electrical

2.1 Stator laminations are pressed into  
housing. This would be adequate  
if tolerances were maintained to  
a sufficient degree of accuracy to  
insure a tight fit.

2.2 A shielded disconnect plug is required if field maintenance is to include carbon removal.

2.3 Breaker points had a deep pit. Running time on unit was approximately 30 hrs. It is claimed that these pts. only break approx. 20 ma. of current; this does not appear to be true from the condition of the pts. Possible that the pts. should have a condenser across them. (There is room for one)

### 3. Operational

3.1 Improved operation would be obtained with a linkage between the throttle and mixture. (Metering rod arrangement)

3.2 A governor would help - especially in one man operations.

3.3 Since operation of this unit must be done with the unit approx. 50' away from the radio eqipt. A combination of paragraphs 3.1 and 3.2 is strongly recommended. If the operation is a two man affair then the present arrangement is adequate.